SYNOPSIS V1.0:

Heavy Ion Latch-up Test Results for the Dallas Semiconductor DS1803 Addressable Dual Digital Potentiometer

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I. INTRODUCTION

This study was undertaken to determine the radiation-induced latch-up sensitivity of the Dallas Semiconductor Addressable Dual Digital Potentiometer. The testing was done at Brookhaven National Laboratory's Single Event Upset Facility. The power supply current was monitored for large increase and the device functionality was verified after each single event latchup (SEL).

II. DEVICES TESTED

The Dallas Semiconductor Addressable Dual Digital Potentiometer, DS1803, has two independently controlled potentiometers. Each potentiometer's wiper can be set to one of 256 positions. Three sample of the Dallas Semiconductor System Controller was tested. All five devices survived the etching process used to remove the plastic surrounding the die. No lot date code information was available. There were no makings on the device other than the part number, DS1803Z-010.

III. TEST FACILITY

Facility: Brookhaven National Laboratory Single Event Upset Test Facility.
Flux Range: $2x10^2$ to $1.3x10^5$ particles/cm^2/s.
Particles: linear energy transfer (LET)

Ion	LET (MeVcm^2/mg)
Ti	18.4
Ni	26.6
Br	37.4
I	59.8

IV. TEST METHODS

Temperature: room temperature

Test Hardware: An VXI-based custom test set was used to supply a nominal input levels to the DUTs and monitor the bias supply current for changes resulting from the radiation exposure. Files were generated for each DUT to track changes the supply current with a measurement accuracy 100 pA. The current was measured and recorded at 10 ms intervals throughout the exposure. An oscilloscope was used to monitor the DUT functionality during the irradiation.

Software: Customized LABVIEW® software provided a user interface to control signals to the DUT. The software also automatically monitor supply currents and generated a file history. The software automatically turned off the DUT power supply when the current exceeded a user defined value. This predefined current is called the limiting current (I_L).

Test Techniques: Tests were performed to screen for the possibility of latch-up and measure sensitivity as a function of supply voltage and particle LET. Test conditions included nominal and worst case levels for the supply voltage (V_{cc}) of 3.3 V and 5.5 V. A normal incidence fluence of at least $1x10^7$ ions/cm^2 was used at each test condition unless an SEL occurred. A beam flux range of $2x10^2$ to $1.3x10^5$ particles/cm^2/s resulted in individual exposures between 10 second and 13 minutes. Both input voltage conditions (3.3 V and 5.5 V) were evaluated at 4 different ions and a several angles of incidence.

Device functionality was monitored by observing the resistance of the potentiometer. If the device current experienced a sudden increased larger than I_L, the power was cycled and the DUT was checked for functionality, we called this an SEL. The DUT functionality information was not saved to a file. From time to time during the exposure, but before an SEL, the device was monitored for changes in the output (this is known as a single event upset SEU). A description of our observation is provided below. This information is provided as a cursory look at the SEU susceptibility of the device. The number of SEUs were not capture, therefore the rate of occurrence in a space flight application can not be predicted.

V. RESULTS

The DS1803 experience several SELs with several ions at several angles of incidence. The latchup current ranged from 51 to 57 mA. During the latchup condition the device was not functional, however the device recovered after a power cycle.

Figures 1, 2 and 3 show the device cross section for an SEL at various LETs for the three DUTs (device under test) tested. The incident particle beam angle relative to the die was changed to obtain effective LETs between those listed in the table. The 3.3 V exposures are indicated by open circles, and the 5.5 V exposures are denoted by the filled in triangles. The data crossed by a solid horizontal line indicate that no events where observed during the exposure, i.e. limiting cross section.

VI. COMMENTS AND RECOMMENDATIONS

In general, the REA group does not recommend the use of devices in space flight applications that experience an SEL at an LET less than or equal to 37 MeV cm^2 / mg. Significant error mitigation approaches that could detect an increase in current and respond rapidly cycle power would be required if these devices are used in a space flight application. Degradation of device lifetime and reliability due to an SEL are unknown.

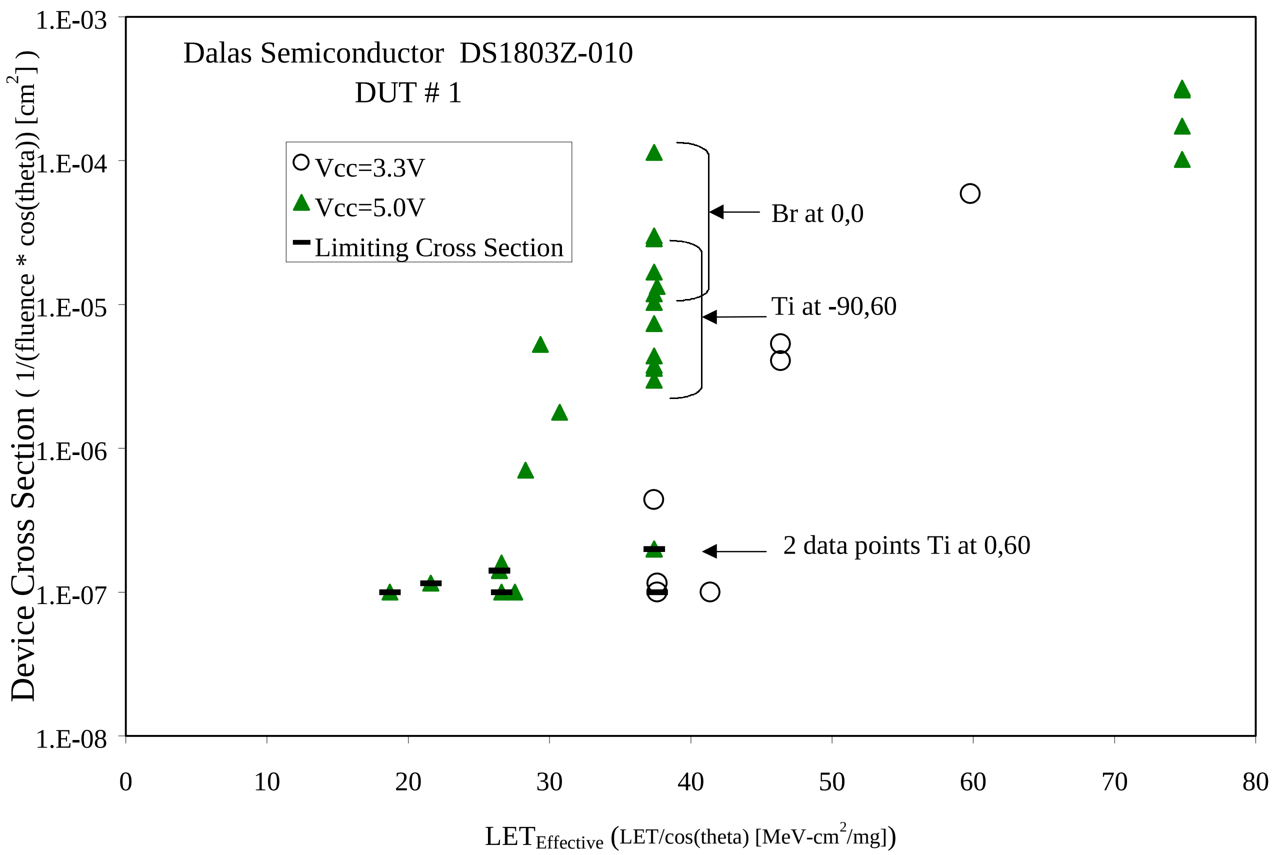

Figure 1. Heavy ion device cross section measurements for DUT#1.

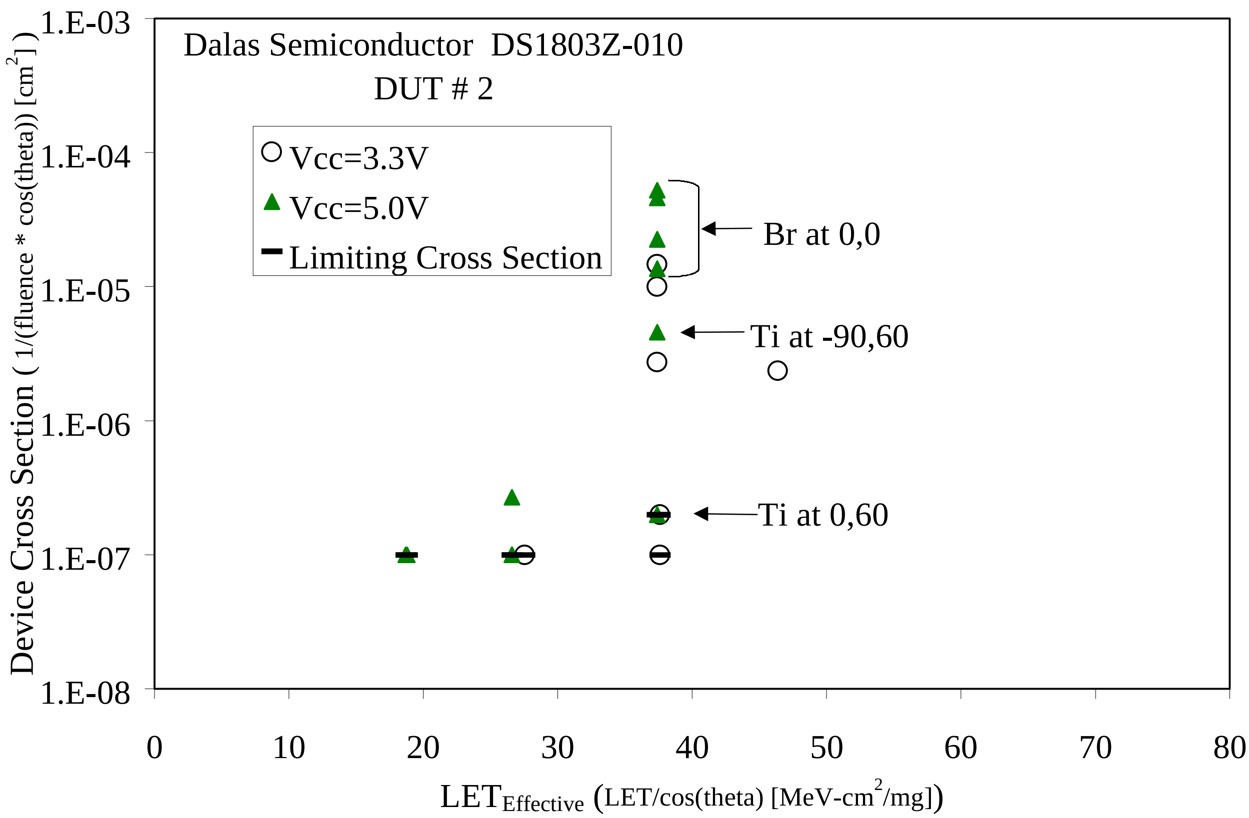

Figure 2. Heavy ion device cross section measurements for DUT#2.

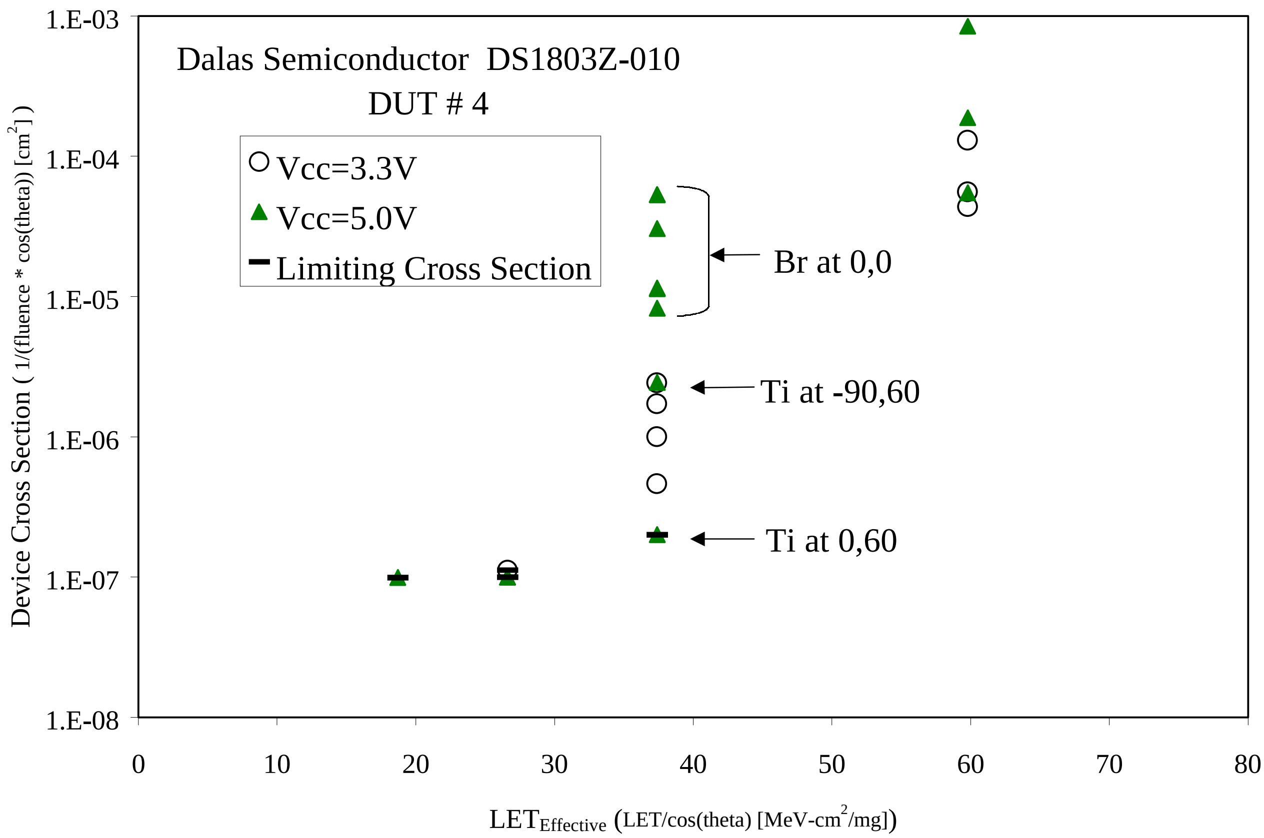

Figure 3. Heavy ion device cross section measurements for DUT#1.